Beyond U-Pb zircon ages alone: Integrating Pb isotopes of tourmaline and feldspar and U-Pb ages of rutile with Hf isotopes of zircon in sediment provenance studies

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A large number of modern, varietal mineral studies of sedimentary provenance rely on the distribution of U-Pb age populations of detrital zircon as the primary dataset. It has become apparent, however, that U-Pb zircon ages may be biased by natural processes (e.g., variable zircon fertility of bedrock sources, hydraulic sorting and grain recycling through multiple episodes of erosion-transport-deposition); insufficient unit sampling; and laboratory procedures (e.g., loss and breakage of grains during sample processing, rejection of discordant ages). While procedures for sampling and analysis continue to improve with a greater understanding of sources of these biases, the effects of biases in nature are best addressed by expanding varietal studies of detrital minerals to consider more than U-Pb zircon ages alone.

To illustrate this approach, we have examined the detrital mineralogy of samples of Early Cretaceous and Late Jurassic sandstones from the deepwater Flemish Pass and Orphan basins of the Grand Banks of Newfoundland. Systematic and quantitative analysis of the abundances, sizes and shapes of the minerals in epoxy mounts of riffled, grain separates of the sandstone samples were made by automated scanning electron microscopy using the Mineral Liberation Analyzer, followed by backscattered electron and cathodoluminescence imaging of representative grains. Discrete, inclusion-free domains in the grains were analyzed by LA–(multicollector)– ICPMS for U-Pb age in zircon and rutile, Hf-isotopes in zircon, and Pb-isotopes in tourmaline and feldspar.

U-Pb zircon ages suggest that the major detrital sources are Dunnage-Gander zone (450 Ma) and Avalon arc (630 Ma) granites, with Grenville (1120 Ma) and Trans-Hudsonian (1800 Ma) gneisses. However, the Hf-isotope zircon, U-Pb rutile and Pb-isotope tourmaline and feldspar data suggest that only the Silurian zircon are first-cycle grains, and bedock sources not seen by the zircon record also contributed significant detritus to the sandstones.